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ABSTRACT

This study presents an overview of collected literature relevant to school buildings, or building in general, in disaster-prone areas, together with some discussion of the role that school buildings, as a universally present community asset, may play in situations of crisis. The natural disasters referred to in this study include cyclones and other strong winds, flooding, earthquake, landslide, and fire. A brief note gives definitions of types of natural disasters derived from some of the works cited. Other emergency situations and hazards involving community action are the subject of occasional references in the text and within the works annotated. A section at the conclusion of each category lists the countries or regions referred to in the references within that category. (Author/MLF)

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EDUCATIONAL BUILDING REPORT 4
UNESCO REGIONAL OFFICE FOR EDUCATION IN ASIA
BANGKOK, THAILAND

NATURAL DISASTERS AND EDUCATIONAL BUILDING DESIGN

An Introductory Review and Annotated Bibliography for the Asian Region

U.S. DEPARTMENT OF HEALTH
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

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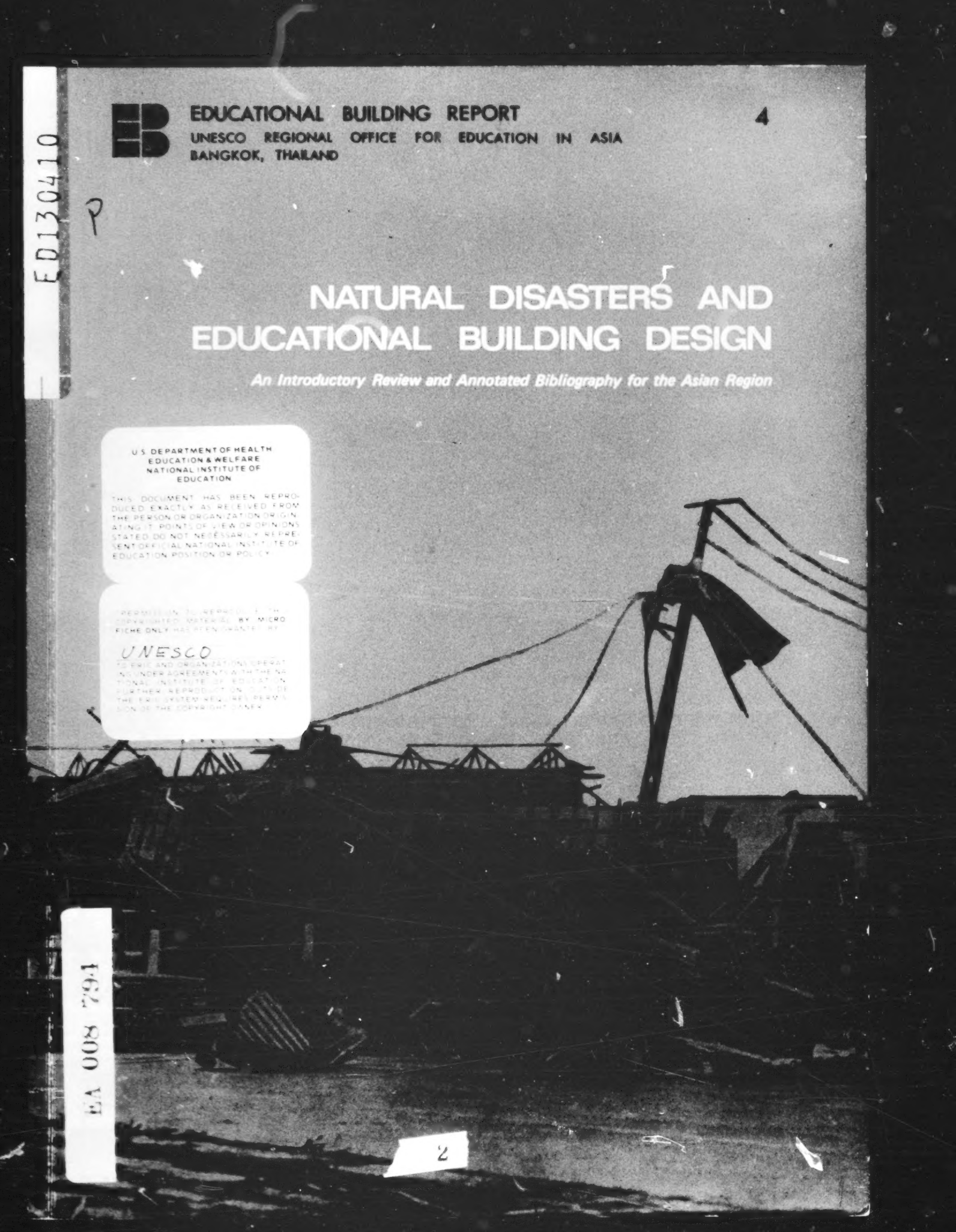

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An Introductory Review and Annotated Bibliography for the Asian Region

by Ian T. Sinnamon

EDUCATIONAL BUILDING REPORT 4

UNESCO REGIONAL OFFICE FOR EDUCATION IN ASIA
BANGKOK, THAILAND, 1976

1330

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I. INTRODUCTION

Purpose of the Study

Many developing countries have in common the two problems linked in this study: an urgent programme for promoting general education, and a proneness to large-scale devastation of environment and life from natural disasters, often occurring in areas of high population density.

This study represents an overview of collected literature relevant to school buildings, or building in general, in disaster-prone situations, together with some discussion of the role that school buildings, as a universally present community asset, may play in situations of crisis.

School building has not been a self-conscious activity for very long, and before the large scale urbanization of populations, the domestic scale was everywhere the scale of school buildings also. It is often claimed that this should remain the case. However, the growth of educational institutions has led, in many places, to a leap from modest buildings deriving from domestic vernacular construction, to much larger multi-storey buildings, more akin to urban commercial structures.

In examining problems of school buildings we therefore deal with a spectrum of structural methods and planning sophistication, yet it is not necessarily true that the more modern examples give the best performance in extreme situations. In flooding, for example, the old wooden vernacular buildings of Brisbane in 1974 withstood many types of flood damage better than newer systems of prefabricated composition panel, or even masonry construction. (The same could not be said regarding fire hazard.) In resistance to strong winds it is hard to generalize, but in the Darwin cyclone of December 1974 there was certainly little to choose between old and new systems in terms of safety. The older roof shapes probably had some advantages in aerodynamic terms. Engineered structures, of course, in most cases withstood wind loading considerably better than those following ordinary vernacular or trade conventions, but even so, a good deal of inadequate principle and practice was revealed.

In earthquakes, there is some advantage in lightweight timber structures over heavier masonry or brick construction, in conventional practice Japanese experience (see D. 18) can be summarized thus:

'If a structure is (i) light (except the underground parts);

(ii) strong (high strength);

and (iii) ductile;

then it is an earthquake-resisting building. Besides, if

(iv) the natural frequency of the structure is quite different from the predominant periods of earthquake motion;

and (v) damping ratio is high;

then it can be called a perfect earthquake-proof structure.'

This specification tends to favour timber buildings over masonry ones, except where strong tensile reinforcing is added. (See Parts IV and VI)

Selection of the controlling restrictions

It is generally accepted that regional characteristics of buildings derive from the response of the inhabitants of the region to aspects of climate, economics, skill and cultural traditions which are important to them. Universal solutions are therefore impossible. In most cases the imposition of precautionary measures on an existing building tradition must restrict freedom to achieve other design goals. For example, the imposition of anti-cyclone measures may preclude the achievement of other goals such as coolness. The temptation to apply uniform standard designs across a wide geographical region ought to be resisted except in emergency situations. Where adequate meteorological or seismic records permit reasonable long-term prediction of the probability of various natural disasters, it is possible to develop design recommendations for building types within the specific region (if professional design skills are also available). Where such records do not exist, or where specific designs are not possible for other reasons, standardization of designs to cover a range of disaster conditions will have to be used, drawing on a generalized brief from wider afield. In the latter case it can be expected that unofficial modifications will occur, because of restrictions of function imposed by all-purpose disaster-proof construction. The cost of such provisions will also, presumably, be higher. If a choice exists, it can be expected that the more flexible solution will work better in the non-specific case. The compromises must however be well-judged.

Siting

Man-made obstructions in the landscape have at times given rise to complications during large-scale natural disasters. Obviously the siting, not only of buildings but of whole settlements, should take into account the characteristics of the region; e.g., foreshore developments obstructing the cycle of dune attrition and replacement, or the danger of flood surge. A recommendation for coastal areas of Bangladesh (see B.6) warns against constructing permanent buildings within $1\frac{1}{2}$ miles of sea coast and banks of estuarine rivers; in seismic areas recommendations frequently include site investigation or search of records to check site location in relation to fault lines or other hazard. Siting decisions relating to micro-climate and town planning on the local scale are of a different order, and not normally subject to overview at a higher level.

Responses to emergency

A social factor acting to mitigate the effects of disasters, in developing countries particularly, is the survival of traditional family patterns, which

can be stretched in times of emergency to care for displaced persons. For example in Managua (see A.5) these social traditions took care of more earthquake victims than the considerable emergency housing effort. This and other experience accumulated in recent years give rise to the frequent comment that emergency provision of housing to meet an assessed immediate need has not always been money well spent. Possibly this points to the need for funds to be spent in preference on a permanent and largely disaster-proof system of communication and shelter to meet short-term emergencies, if this can be done economically, providing a little more time for the careful planning of more permanent shelter. It is true that these two measures may well be funded from different sources, and in that sense they are not, perhaps, true alternatives.

A suggestion arising from the present study is that the network of pre-existing, politically and administratively neutral, familiar and easily identified premises, i.e., schools, might well be the basis for both public shelter and communication in such situations, and that a case can be made for their design to serve this public purpose in addition to their acknowledged educational role. In the Darwin cyclone of 1974 (see B.20) the Casuarina High School was opened up by citizens as a refugee camp; this use of school facilities in emergency has become a strong pattern where school buildings have escaped the general destruction.

Sometimes the educational authority may be in advance of other authorities in setting standards for building codes; the State of California Education Code requires geological investigation before acquiring a school site, or altering an existing school. In most developing countries there will be little accumulation of such data, and school building programmes may need to take a lead in surveying site characteristics and introducing standards. Legislation and regulations for disaster mitigation are at a rudimentary stage of development in most countries. The National Workshop on Building Practice for Disaster Mitigation, held at Boulder, Colorado, in 1972 (see No. A.11) has been one of the most comprehensive attempts so far at rationalizing disaster mitigation in the U.S.A. It produced a total of 71 general recommendations for new policies and practices. It would be fair to say that most countries have not yet organized their building industry or developed protective policies to that extent.

II. HOW TO USE THIS DOCUMENT

Subject categories

The natural disasters referred to in this study include cyclones and other strong winds; flooding; earthquake, landslide and fire. Other emergency situations and hazards involving community action are the subject of occasional references in the text and within the works referred to. The main categories within the bibliography (Part VI) occur in this order:

A. General	(Nos. A.1 - A.11)
B. Strong winds	(Nos. B. 1 - B. 20)
C. Flood	(Nos. C.1 - C. 8)
D. Earthquake, fire and associated hazards	(Nos. D.1 - D. 40)
E. Codes and standards	

A section at the conclusion of each category lists the countries or regions referred to significantly in the references within that category.

A brief note (Part III) gives definitions of types of natural disasters derived from some of the works cited. Part IV comments on aspects of the various categories within the bibliography. By its nature this section cannot indicate the detail or thrust of the collectivity of references, but can only draw attention to areas of clearest significance to the subject of the study. The special case being made for schools as fulfilling a public role during disasters is developed in Part V.

This argument derives from the facts and experiences referred to in the bibliography, but in fact few references given are very specifically devoted to schools alone. Whilst few structural principles apply to the design of schools to the exclusion of other building types, the decision as to which buildings or parts ought to be designed to withstand disasters, and which can, if necessary, be written off, is relevant to this discussion, and should be part of the design brief.

Annotations to references aim to indicate the subject matter and the nature of the work referred to; technical, philosophical, exhortatory, prescriptive; whether illustrated or not; and length. In some cases items listed have been unobtainable at the time of compilation, but have been included with what indirect information was available. Such items are indicated by an asterisk* preceding the reference number.

The category Codes and Standards lists those standards and practices to which reference (sometimes critical) is made within the items cited, also some obtained independently of references. Some codes have been recently formulated, some have been established without legal backing or enforcement apparatus, some are still evolving. Reference is also made to standard practices, and to statutes which, without being building codes or standards, are considered to have some relevance. Comprehensiveness in this area is not considered practicable, and has not been attempted. In particular, fire codes have not been searched.

Numbers given in brackets used to illustrate points in the text (e.g. D.17) refer to items listed (by category and alphabetically, normally by author) in the bibliography in Part VI.

III. DEFINITIONS

The term "natural disaster" covers a wide range of occurrences - varying kinds and speed of winds, earthquakes, floods deriving from rainfall, tidal wave or surge, landslide or fire. The exact meaning of terms used herein may vary between the various works and authors referred to. The following definitions and descriptions are in most cases derived from references included in the bibliography, but do not necessarily cover all usages.

Wind Conditions

A number of distinct types of strong wind are included: typhoons, cyclones and hurricanes; thunderstorms; tornadoes and extra-tropical storms. Collected climatological and load data associated with various categories are incomplete, and prediction of occurrence is inaccurate. Winds can be divided into relatively long-term (cyclones and extra-tropical storms) and short-term disturbances (thunderstorms and tornadoes).

Cyclone or Hurricane or Typhoon or Baguio is a circular system of strong wind, covering a great area and ranging from high to low velocity. They have been studied closely and fully documented in some cases, but prediction of cyclone paths is not advanced.

Whirlwind is an eddy of air of minor proportions which may whisk up dust or light debris to an intermediate height.

Tornado is an intense, fairly localized storm of extremely high velocity, composed of a translating vortex with high winds and a centre of very low pressure. Tornadoes cause the most devastation of all wind types, but little data has been accumulated; to do so is very difficult. Design to withstand tornadoes is rarely attempted.

Waterspout is a tornado or violent whirlwind over water.

Gale is a strong straight wind.

Thunderstorms, short duration storms, can give rise to short-term violent winds. They have usually been recorded and included in normal site data. Action by gusts, however, has not been fully studied.

Earth Movement

Earthquakes are normally caused by geological movements far removed from human agency, but blasting and other activities effecting changes in local earth pressures (e.g. filling a large dam) can cause moderate earthquakes. Natural earthquakes can be predicted in time and location with some accuracy if seismic data has been accumulated over a sufficient

period. Earthquake risk is commonly measured on two levels, one at which design for safety of life only is possible and the building may be badly damaged; and one which should be resisted by the structural design of the building with little damage.

Ground shaking normally does not result in permanent movement, but can cause heavy damage unless designed for. Intensity of surface vibration is affected by soil conditions, epicentral distance, azimuth from source to site, and direction and extent of faulting.

Zoning risk maps show the characteristics of particular sites on the map.

Permanent ground movements can include landslides, lurching, liquefaction (subsidence and lateral flow of saturated soils) and fault break (surface rupture).

Faulting can result from earthquakes. Fault ruptures can extend to the surface and severely damage struc ures. If the risk of faulting can be estimated, zoning can control building activity in hazardous areas. However, damage to underground services from faulting may still cause difficulty.

Volcanic hazards can be calculated to some extent from local history and measurement, and land use regulated accordingly.

Floods

Flooding may be caused by extreme rainfall, storm surge, tsunami or tidal wave, or dam failure.

Storm surge is wind-generated waves and surf, and may occur where strong winds can affect large expanses of water. Erosion by storm surge can be aggravated by uncontrolled land use, interference with foreshore, drought or build-up of sediment.

Tsunami is a sea wave caused by disturbance of the ocean floor by seismic movement.

Building regulations have existed since at least the time of Nero, if not Hammurabi. They are established by law and prescribe minimum acceptable standards for safety of people and property involved in construction and use of buildings. They derive from standards established over a period of time and revised in the light of recorded performance in field conditions. They are not construction handbooks or necessarily standards of good practice in their own right. 'Regulations' and 'Codes' are usually mandatory while 'standards' may be voluntary. In developing countries (and others) codes of practice do not always exist; there is also frequent confusion and overlapping between the recommendations of different groups having varying jurisdiction.

IV. NOTES ON THE PROBLEMS OF DESIGN FOR NATURAL DISASTERS

Natural disasters most frequently result from meteorological or geological disturbance. The natural agents of destruction can, in the broadest sense, be divided into two groups. The failure of structures and fixings can be caused by abnormal loads from wind or ground movement. Flooding and torrential rain can cause erosion, collapse or disintegration of buildings, and landslides. In each case loss of human life is the usual accompaniment. Frequently further loss is caused by subsequent fire or disease. Combinations of several of these factors are common, perhaps even the rule.

In seeking a man-made response to the large scale destruction so familiar from daily news (if not from real life), a thousand problems of some urgency present themselves. For present purposes we can regard the main areas of difficulty as these two: firstly, the measures which can be taken in design, construction and use of buildings and facilities to reduce the risks of physical damage to, or by, the constructed fabric. Secondly, how to plan for the safest and most efficient organization of relief in situations of actual emergency. In every case where these problems are tackled, there will be a different pre-existing social, political and economic context, not least of which will be the policy of the responsible government, and its relative priorities in allocating resources of money, facilities and manpower for the purpose.

Wind

Strong winds cause pressure loads on outside sections of a building and, if air can penetrate, also on the inside by a build-up of pressure. Buildings tend to fail because they are primarily designed to resist vertical or gravity loads. Cyclonic winds cause different loadings - lateral loads, uplift and internal pressure. The most common failure resulting from sudden wind entry has been the lifting off of the roof. Damage from flying debris, often severe, cannot be excluded but can be reduced by protection of glass and other relatively weak surfaces. Design against structural failure involves acceptance of reasonable maximum loads; it must take into account geographical location, and local terrain and exposure.

The accumulation of meteorological data such as frequencies, tracks and intensities of cyclones in the region is necessary for the best and most economical decision about wind resistance to be made in the particular case. (See Fig. 1 on p. 8).

Wind-loading codes should take into account variables such as terrain (e. g. No. B. 16).

The basic requirement of wind proof construction is that the structure be fully 'tied'. The decision as to the strength of the ties, however, will have to be empirically based. As there is no absolute upper limit for wind speeds in structural design, a decision must finally be made, based on available data, as to what is an economically reasonable maximum load, and consequently which parts of the built fabric must withstand it; aiming at some consistency in the decisions made.

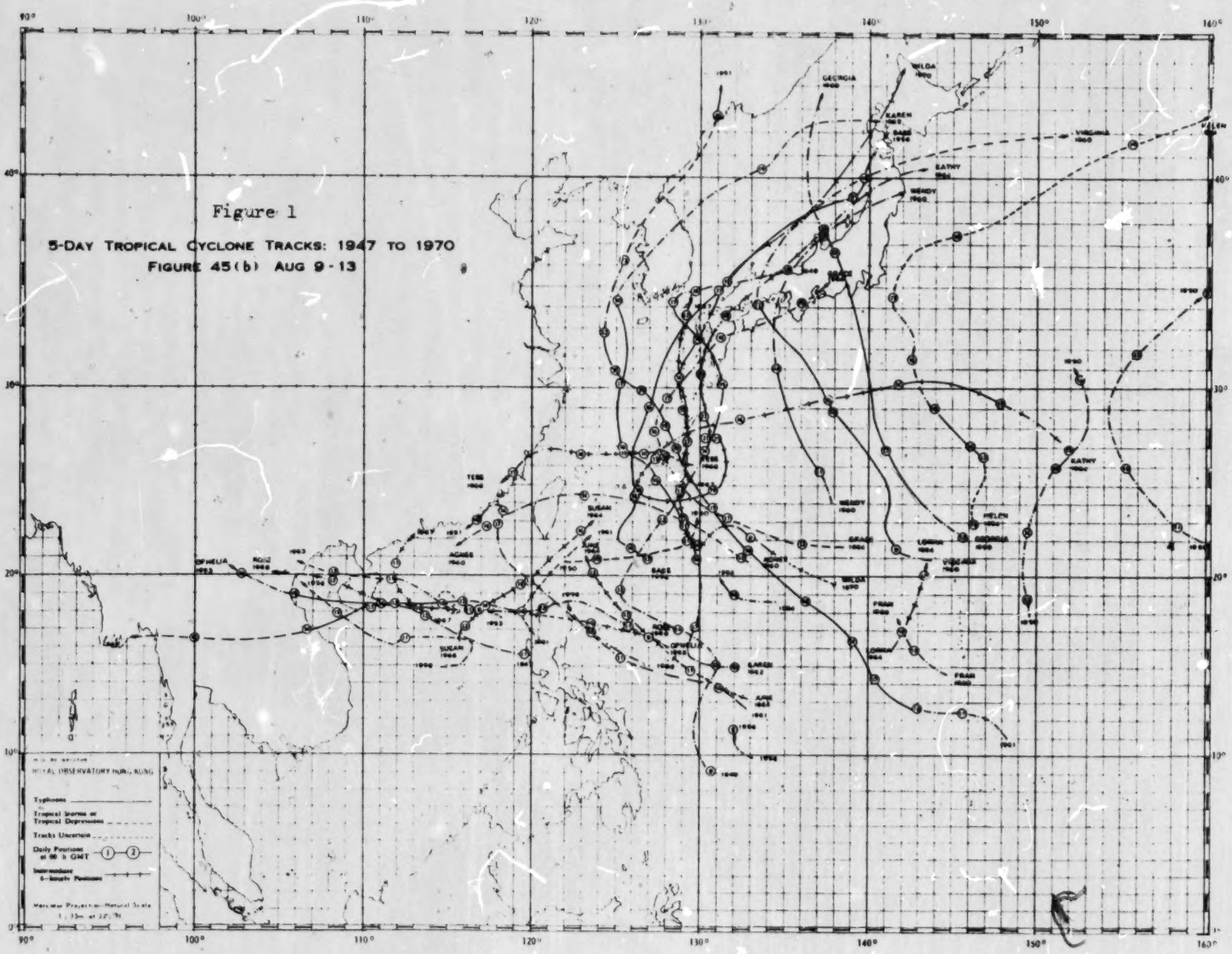

Figure 1

5-DAY TROPICAL CYCLONE TRACKS: 1947 TO 1970
FIGURE 45(b) AUG 9-13

Flooding

Damage and difficulty associated with flooding may include the following:

(i) the strain and breaking of structures under extreme loading from a dynamic body of water;

(ii) damage caused by buoyancy of submerged materials or exploding pockets of trapped air;

(iii) turbulence from the force of swollen rivers and subsequent secondary damage from bow-waves of vessels doing rescue or other work;

(iv) water-borne debris - vessels, buildings and demolished building materials, trees and animals;

(v) sometimes stranded animals have entered floodbound buildings in numbers and caused heavy destruction;

(vi) mud left behind after the flood can permanently affect some materials and finishes, may endanger health and leave a permanent smell;

(vii) services, particularly fallen electricity wires and overflowing sewage systems can be a serious hazard; reticulated water supply can be temporarily fouled, and stormwater drainage systems if not cleared immediately afterwards may become inoperative; a second flood situation following shortly afterwards may thus be even more damaging than the first;

(viii) health risks may be caused by decaying animal and vegetable matter unremoved because of disruption of normal cleansing services;

(ix) temporary accommodation of flood victims and relief workers may be strained, particularly where transport services are dislocated or insufficient;

(x) normal communication networks may be inoperative; emergency means of obtaining and conveying information may be required, ranging from helicopters to two-way business radio systems to volunteer runners, or swimmers.

There is a strong need for known emergency communication centres. Unambiguous warnings and predictions from authorities, clearly distinguished from rumours, will help prevent unnecessary panic and movement. As movement to high ground will accompany flooding, it is clearly desirable for some at least of any available high ground to be available as a community facility.

Earthquake

Only a small part of the earth is subject to severe earthquake hazard - the borders of the Pacific Ocean and a zone from Southern Europe to the Eastern end of Indonesia. (See Figure 2).

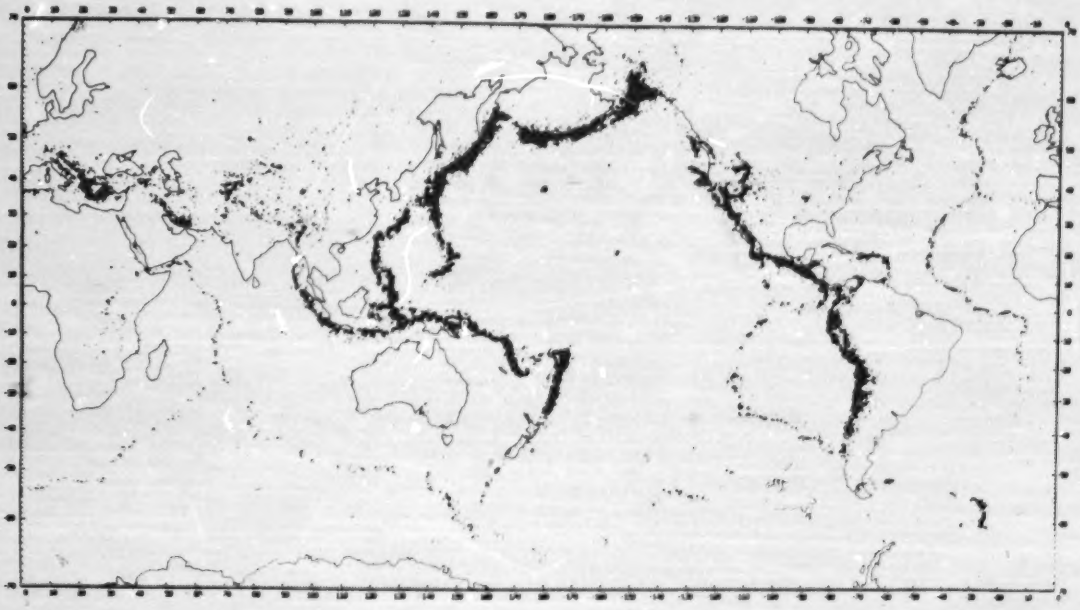

Figure 2.

Useful data on earthquake damage has been collected for many years. The International Association for Earthquake Engineering publishes world directories of bodies and individuals doing relevant work and proceedings of world conferences held at about four-yearly intervals; and assists in promoting regional and national conferences.

The bibliography lists extensive examples of earthquake-resistant recommendations and codes. References range from traditional masonry and timber construction evolved over centuries (D. 24) to precisely-calculated engineering codes. The typical experience of various Japanese structures is summarized (see D.18); see also Figure 3 for Japanese timber details.

Wooden structures, if braced both vertically and horizontally, in walls and roof and well fixed to reinforced footings, are among the most durable, particularly when firmly reinforced at joints with metal plates and bolts; however, they are fire hazards if collapse or damage affects services of electricity or gas. Masonry structures being heavy, brittle and weak are generally disallowed unless heavily reinforced; reinforced concrete structures, although often damaged in earthquake, can be adequate if properly engineered, as can steel-framed reinforced concrete, a characteristic Japanese structural type; precast structures often fail through weak points at the joints. Steel-framed structures are normally favoured in Japanese practice, particularly for high-rise buildings.

Fire

Fire risk frequently accompanies other forms of natural disaster which involve the destruction of services; most particularly earthquake. Fire hazard is, however, much more readily recognized and taken into account in building codes and practices. The present work does not attempt a listing of the many studies and codes on fire-resistant construction, although the need for fire resistance is not neglected in the general section.

The development of standard practices

It has been observed that rule-of-thumb standards have had to be continually revised in the light of performance in disasters. Simple recommendations of the workbook type serve a purpose, but such operations must either be subject to progressive inspection by scarce experts or trained officials, or must be uneconomically conservative; or both. Properly engineered design, in every case, is desirable but impracticable. Even then, the engineering design must be based on conventions which derive from calculations of acceptable risk, and may yet be superseded in the light of performance (See No. B. 20). The 1972 workshop in the U. S. (see No. A. 11) studied many existing and needed standards. Its recommendations (No. A. 11, p. 7-33) ranged from land use planning to the explicit degree of acceptable risk in design calculations, to specific provisions in existing building codes. Gaps needing research were also identified. Most countries need extensive local study and research directed at establishing such standards. Unesco has instigated an extensive programme of such studies (e. g. A. 1, D. 5). Other bodies engaged in studies include the United Kingdom Building Research Station (e. g. D. 11, D. 16), and the United States National Bureau of Standards (e. g. A. 11, B. 9, B. 10, B. 14, B. 15, D. 27) which publishes periodical studies of great value in the Building Science series (from Office of Technical Information and Publications, National Bureau of Standards, Washington, D. C. 20234).

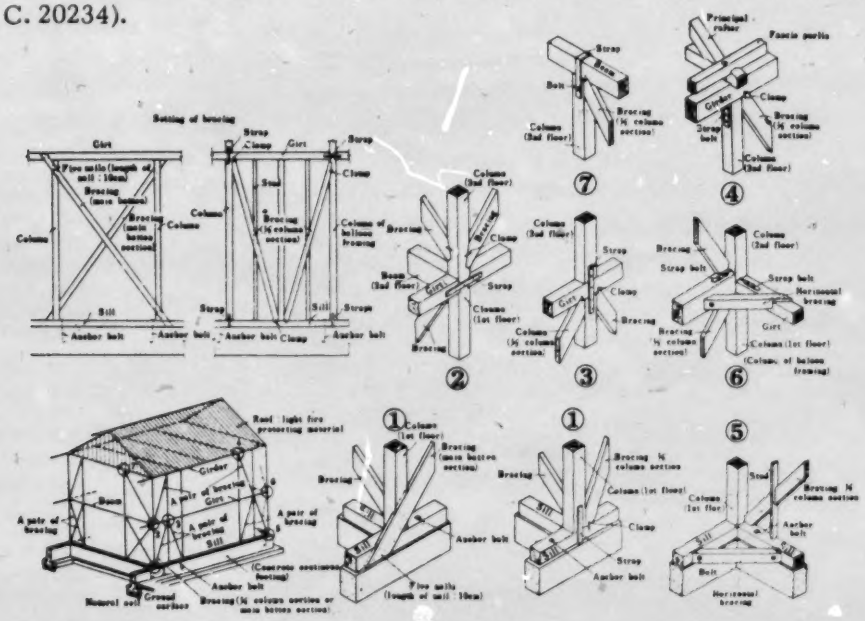

Figure 3. *Structural details of wooden houses*

V. SCHOOLS - A SPECIAL CASE

An alternative method to the expensive, and probably impractical proposal to build only disaster-proof structures, is to accept that in a maximum disaster most communities can expect widespread damage and disruption. The problem of damage from flying debris from a cyclone, for example, will not disappear if every item of building fabric is firmly fastened. If limited resources are devoted to keeping the essential basic facilities of the community functioning, ordinary human adaptability and makeshift will take care of many problems in the short term. There are particular buildings within the community, and particular parts within the buildings, which will perform essential functions at such times. If these are designed to meet extreme situations, and other parts designed on a less restrictive brief, there should result an adequate compromise between amenity, economy and emergency provision. The local school complex could be considered as one of the community amenities most appropriate to this public role.

School buildings usually embody a number of inherent advantages for performing the role. Some of these emergency functions, it is suggested, ought to be considered for adoption into the initial design brief for new regional programmes of school building. Although economic restrictions are general in school building, there is sufficient overlap between the functions of school and disaster relief station to indicate special planning and structural requirements, and perhaps the need for communications equipment in excess of the most basic provision for educational purposes.

The two most pressing needs in large-scale disasters are usually shelter and communications. These could be expanded to include facilities for assembly, emergency medical treatment and provisions of food or clothing, storage, and a system of transport or rescue. A requirement of a different kind is the separation of large numbers of evacuees, inevitably in a state of distress and disorganization, from the emergency administration and policy-making apparatus. Experience suggests that this last function is best performed in a separate location, probably police station or post-office.

The siting of school buildings has economic and social importance, apart from serving as educational brief. Normally the school occupies a fairly central location in relation to the population it serves, and occupies a large piece of land. Its siting frequently makes use of both good and poor land - good because necessarily centrally located and adequate for the expenditure of considerable public funds, and commonly poor in parts because outside playground or recreational activity is frequently allotted low-lying or inferior land, which may itself be inundated in a flood emergency. For many purposes, however, the school can supply both generous open space and secure, elevated and spacious enclosed space for administrative use during emergency.

Schools - a special case

Where acute need for sheltering large numbers may arise, open level areas are usually available at schools for erecting temporary structures (tents, inflatables) close to the potential information centre. Re-usable lightweight buildings from a central relief organization would seem to have a role in such situations. Taking the extreme example, the U.S. pavilion at Expo '70 in Osaka, a translucent vinyl-coated fibreglass membrane 465 feet long and 274 feet wide - city block size - was supported on .03 pounds per square inch air pressure, and was designed to resist all known forces from earthquakes to 125-miles-per-hour typhoons and perforations. Smaller adaptations could perhaps become standard equipment for airborne disaster relief.

The design of the school itself can reasonably be made subject to the wider needs of emergency accommodation. A recommendation for two-storey school buildings in flood-prone areas (e.g. Bangladesh, see No. B.1) is an example. The experience and policy of local or regional governments could provide guidance as to the relevance of such guidelines in the particular case.

The designer will eventually be left with the decision of how disaster-proof his building will be. Recommended building codes follow in the wake of disasters and prescribe new performance and practice. By their nature these are conservative and restrictive: do not build roof overhangs or verandahs in cyclonic areas; keep glass areas and opening sizes to a minimum. In areas of characteristically high humidity and glare, a compromise will be required to make the building habitable in ordinary times. An indestructible service 'core' is another solution, accepting the possibility of the loss of other elements. On the larger scale, the school may be a part of the community's service core.

VI. BIBLIOGRAPHY

General

(A.1) Asian Regional Institute for School Building Research, Colombo. School building design - Asia. Colombo, 1972. 304 p., illus.

Includes major research and design work done by ARISBR under Unesco sponsorship from 1966 to 1972.

A comprehensive collection of relevant data for school design across the range from educational background to detailed design for specialized teaching facilities. Includes (p. 261-266) notes on school building for conditions of strong winds and earthquakes.

(A.2) Atkinson, George. "Rehabilitation and reconstruction of housing and facilities in cases of national disasters". Ekistics, vol. 23, no. 136, March 1969. p. 153-160.

Report abstracted from United Nations document E/C/6/52/Add. 6. prepared for Fourth Session of UN Committee on Housing, Building and Planning, Geneva, Switzerland, September 1966.

Claims action needed in 4 spheres: educational, administrative, research and technical; stresses need for building regulations and field inspectors; also comprehensive disaster legislation to prevent disaster, mobilize rescue workers, alleviate hardship, facilitate reconstruction; new methods and organization of construction, opportunity to modernize the country's building industry and assessment of innovation; appropriate field for assistance programmes before the event; town planning as an aid to preventing disaster (particularly fire) and in reconstruction.

Includes table, 'Ways in which homeless may be housed after a disaster'. Advocates critical path planning in the reconstruction process.

*(A.3) Cochran, A. A selected, annotated bibliography on natural hazards. New York, United Nations. [n.d.] (Natural Hazard Research - Working Paper no. 22)

*(A.4) Dacy, D.C. and H. Kunreuther. The economics of natural disasters. London, Collier MacMillan, 1969.

(A.5) Davis, I. "Disaster housing: a case study of Managua". Architectural Design, vol. 45, January 1975. p. 42-47.

Reports on the use (and non-use) of emergency shelter provided by various aid authorities following the 1972 earthquakes. A number of prefabricated,

low-cost and/or fast-assembly systems were provided and tested in various ways. Poor-fit solutions were rejected or modified on official or unofficial (self-help) basis.

Lists criteria for post-disaster housing in situations of no exposure risk; tropical or subtropical climate, pre-existing housing shortage and general poverty; divided into two phases, weeks 1-6, and week 6 onwards (permanent housing).

Includes photographs of typical systems and squatter housing.

(A.6) Emmerich, D.G. "Paper house review". Architectural Design, vol. 40, October 1970. p. 499-505, 523-526.

Illustrates and evaluates about thirty lightweight buildings, many prefabricated and/or temporary; and some experimental. Includes 'Foam Dome', the Faber-Fabriken Bayer A.G. development, in co-operation with German Red Cross and Turkish Red Crescent, the transportable production unit which produces up to fifteen rigid polyurethane domes per day, used for temporary housing for earthquake victims (referred-to also in A.6).

(A.7) Flores, Ambrosio R. "Present day civil engineering problems in the Philippines". Philippine Economy and Industrial Journal, vol. 21, no. 1-2, 1974. p. 42-47.

Includes brief description of disaster prevention and mitigation developments.

(A.8) Gay, W.G. and W.W. Cherault. Improving your community's emergency response: an introduction to disaster planning. McLean, Va., Human Science Research, Inc., 1973. 131 p. (Final report for Defense Civil Preparedness Agency, Department of Army)

Describes local comprehensive preparedness planning; based on research findings and experience involving human behaviour and organization in disaster. Written at introductory level.

Includes advice on handling people during emergency, use of communications and pre-planning.

(A.9) Natural Disaster Organization on the Darwin Relief Operation, Canberra. Darwin disaster: Cyclone Tracy. Canberra, 1975. 68p., illus.

Gives chronological sequence of events and actions resulting from destruction of Darwin on Christmas Day, 1974, including emergency measures, mass evacuation, communications, restoration of essential services and planning reconstruction.

(A.10) Olgyay, Victor. Design with climate. Princeton, N.J. Princeton University Press, 1963. 190 p.

A basic textbook of climatic design. Includes chapter on wind effects and air flow patterns, and wind-control measures.

(A.11) "State Review", Architecture in Australia; Schools Issue, vol. 63, no. 5, 5 October 1974. p. 75-94.

Gives examples of new school buildings in Australia including conventional and developed planning and construction, and (p. 78) the Bini Shell multi-purpose centre, a 'revolutionary structural technique of inflating a membrane covered with wet, specially reinforced concrete' being developed in New South Wales schools, consisting of a 36 m. diameter shell plus ancillary spaces.

Further development of this system is taking place.

(A.12) Wright, R., S. Kramer and C. Culver. Building practices for disaster mitigation. Washington, D.C., U.S. Department of Commerce, National Bureau of Standards, 1973. 475 p. (Building Science Series no. 46)

Proceedings of a workshop sponsored by the National Science Foundation, Research Applied to National Needs Program and National Bureau of Standards at Boulder, Colorado, September 1972 Center for Building Technology/Institute Applied Technology National Bureau of Standards, Washington D.C.

Workshop produced recommendations addressed to policy makers in government and industry, practitioners in engineering, architecture, land-use planning,and earth and meteorological sciences. Evaluated current building practices, defined opportunities for improving them from research findings and recommended research to fill gaps in knowledge. Objectives included avoidance of human suffering, reduction of property loss, maintenance of vital function in buildings under conditions threatening disaster.

Major divisions of contents are (a) Policies for Disaster Mitigation: Action at Government levels; Actions by Insurance Industry; Action by Design and Construction Community. (b) Practices for Disaster Mitigation: Actions by professional practitioners; Actions by standard writers; Actions by researchers.

Includes extensive range of studies, illustrated and with bibliographies.

Regional breakdown of above items

International	A.2, A.3, A.4, A.6, A.10
Asia (see also under countries)	A.1
Australia	A.9, A.11
Central America	A.5
Philippines	A.7
U.S.A.	A.8, A.12

Cyclones, strong wind

(B. 1) Asian Regional Institute for School Building Research, Colombo. Primary school building programme in East Pakistan with special reference to cyclone-affected areas, by C.E. Finney, D.J. Vickery and F. Kulka. Colombo, 1968. 109 p.

A report and recommendation to the Director of Public Instruction, Colombo, April 1968. Material collected and prepared by C.E. Finney and D.J. Vickery (ARISBR) and F. Kulka (Unesco consultant).

Recommends two-storey structures for all future schools in areas prone to cyclone flooding, and provision to be made for emergency refuge during cyclones and floods. Outlines alternative programmes for primary school construction for period 1970-1975. Recommends development of three types of schools; use of local craftsmanship and practices; and methods of calculating future primary school needs by creating a Building Planning Data Bank.

(B. 2) Asian Regional Institute for School Building Research, Colombo. Typhoon: construction of typhoon resistant buildings. Colombo, 1972. 49 p., illus.

Booklet prepared by Finney and Mooij of ARISBR as a self-help primer for headmasters and house owners; gives simple guidelines for reducing damage to buildings, injuries and inconvenience to people. Explains in simple graphic form forces on structures, causes and methods of destruction, and simple means of prevention of damage by maintenance, on-site precautions, design principles, and simple structural alterations and improvements to increase stability during or after construction.

(B. 3) Australia. Cities Commission. Darwin planning guidelines; a second planning report on the future Darwin prepared on behalf of the Department of Northern Territory for the Darwin Reconstruction Commission (Draft). Canberra, Australian Government Publishing Service, 1975. 44 p.

An Australian Government promise to rebuild Darwin without delay following cyclone Tracy gave rise to a study of options for reconstruction and correction of past mistakes.

Makes recommendations for planning in areas subject to tidal surge and the programming of reconstruction of economic and social fabric. Public comment and participation were sought.

(B. 4) Australia. Department of Interior. Bureau of Meteorology. Meteorological summary: frequencies, tracks and intensities of tropical cyclones in Australian region 1909 to 1969, by Coleman F. Canberra, 1972.

Investigates statistical data of tropical cyclones and presents facts illustrating the behaviour of past cyclones. Tabulates monthly frequencies of cyclones for season November to June, in decades, and for sections of the Australian coast. Includes maps of cyclone tracks, similar to the map which is reproduced as Figure 1, page 8.

(B. 5) Design for tropical cyclones. James Cook University of North Queensland Vacation School, August 1972. Collected papers includes the following:

Vickery, B. J. 'Wind effects on structure' (from forthcoming book by Davenport and Vickery).

Fairweather, I., 'Problems for engineers following cyclones (pp. 21).

Daniels, N. R., 'Problems for architects following cyclones' (pp. 22).

Aynesley R. M., 'Protection of buildings against cyclones' (pp. 44 including 31 references).

Macks, K. J., 'Design of claddings for cyclonic conditions' (pp. 34 + pp. 14 of architectural details and drawings).

Walker, G. R., 'Structural design of dwellings for tropical cyclones design philosophy'.

(B. 6) East Pakistan. Institute of Engineers, Dacca. Report of Institute of Engineers Sub-Committee on cyclone disasters in East Pakistan. Dacca, 1962. 132 p. (Technical Report Series no. 1)

Reviews conditions preceding and subsequent to cyclones, suggests co-operative action to construct emergency shelter (as school or common meeting ground) together with protected supply of sweet water. Recommends 2 floors for all public buildings, to provide minimum area of accommodation above flood surge level; also recommends protection by afforestation zone adjoining coast line and restriction of building within $1\frac{1}{2}$ miles of sea coast and banks of estuarial rivers; and other protective planning measures. Includes 16 appendices and numerous explanatory diagrams and photographs.

(B. 7) Flores, Ambrosia R. "Design methods for wind effects on buildings and structure". Philippine Architecture, Engineering and Construction Record, vol. 19, no. 1, April 1972. p. 32-60.

Gives definitions of wind phenomena (gale, tornado, cyclone etc.); presents design methods for several typical structures; tall buildings (over 30 metres); low buildings - offices, schools, mills, houses; special structures - stadia, open sheds, signboards etc; gives external design data and constructional detail in illustrated examples.

(B. 8) Hong Kong. Royal Observatory. Tropical cyclone climatology for the China seas and Western Pacific from 1884 to 1970; vol. I: basic data, by P. C. Chin. Hong Kong. The Government Press, 1972. 166 p.

(B. 9) Marshall, R.D. and N.J.M. Raufaste, eds. Development of improved design criteria to better resist the effects of extreme winds for low-rise buildings in developing countries. Washington, D.C., U.S. Department of Commerce, 1974. 170 p. illus. (N.B.S. Building Science Series no. 56).

Reports on an International Workshop held in Manila on 14-17 November 1973 on wind damage; jointly sponsored by USAID, NBS and the Philippines Advisory Committee. Presents recommendation, workshop programme, 5 reports and 9 technical articles. Primary topics discussed were: wind - and aerodynamics, structural related technology, socio-economic and architectural considerations, and codes and standards. An additional purpose is to integrate workshop information into the three-year AID project to improve design criteria for wind-resistant low-rise buildings in developing countries. Draws on experience from Philippines, Bangladesh, Jamaica, U.K. and elsewhere.

Includes papers on wind tunnel modelling (Marshall), lessons learned from past investigations (Pfrang) and relevant provisions of National Building Code of Republic of Philippines.

Includes diagrams, illustrations and several bibliographies.

(B.10) Marshall, R.D. and H.C.S. Thom, eds. Proceedings of technical meeting concerning wind loads on buildings and structures. Washington, D.C., U.S. Department of Commerce. National Bureau of Standards, 1970. 170 p. illus. (Building Science Series no. 30)

Conference was held to promote exchange between researchers and practising engineers.

Emphasis is on tall buildings, but some analysis of the influence of architectural features (parapets, mullions, overhangs etc.) is given.

(B.11) Mooij, D. and A. Sikkema. Survey of buildings damaged by the cyclone of 12.11.70 in East Pakistan. Colombo. Asian Regional Institute for School Building Research, 1971.

Reports on a survey of a number of buildings ranging from temporary corrugated iron buildings with wooden frames to permanent buildings of reinforced concrete and up to two storeys. A major purpose of the survey was to obtain guidelines for the design of cyclone-resistant schools. Aspects of the disaster included strong wind (150 m.p.h.) a tidal wave (20-40 feet high) and subsequent waves on the flood water, and a back flow of water as the cyclone receded. The authors stress that even this did not reach maximum local conditions for such a disaster. Includes recommendations for future practice for foundations, brick walls, wooden structures, reinforced concrete, and for site planting, location of building sites, supervision of construction and documentation.

(B.11.A) Newberry, C.W. and K.J. Eaton. Wind loading handbook. London, Department of the Environment. HMSO 1974. 74 p.

Handbook written as a guide to British Standard Code of Practice on wind loading (CP 3 : chapter V ; Part 2 : 1972). Explains more fully the data contained in the code and extends its coverage. Includes information on probable maximum wind speeds, effects of topography, environment and location on design wind speed for a particular site. Describes relationship between speed of the wind and dynamic pressure it exerts on a structure, patterns of flow around buildings and effect of building shapes and architectural features such as balconies. Well illustrated, complete with photographs, diagrams and tables, and supplemented with 23 references.

(B.12) New Zealand Building Research Association. Wellington. Bulletin No. 18. Beware of the wind, 1961. 2 p.

Discusses general principles of wind pressures and probable points of failure. Refers to Model Building By-law which does not provide for cyclonic wind (max. speed 75 mph)

Bulletin No. 35 Recommended glazing sizes of high winds.
No. 135 Wind loads : some problems and design aspects.

*(B.13) Philippines. National Disaster Control Center. Rehabilitation program (December 1970 - June 1971). Damages due to typhoons : Pitang, Sening, Titang, Yoling. Quezon City, 1970.

(B.14) Rafauste, N.J. and R.D. Marshall. FY 74 progress report on design criteria and methodology for construction of low-rise buildings to resist typhoons and hurricanes. Prepared for Office of Science and Technology. Washington, D.C., Agency for International Development, 1974.

Includes reports from Philippines, Caribbean and Indian Ocean. Illustrated with examples of low-cost building systems : Jamaica, Bangladesh.

Appendix E given examples of housing in extreme winds in three areas (Philippines, Jamaica, Bangladesh); well illustrated by simple diagrams.

(B.15) Reps, W.F. and E. Simiu, eds. Design, siting and construction of low-cost housing and community buildings to better withstand earthquakes and windstorms. Refer to (D.27)

(B.16) Saini, B.S., S.V. Szokolay and F. Woolard. Evaluation of housing standards in tropical Australia. University of Queensland, Department of Architecture, 1975, 88 p. illus.

Examines standards of residential accommodation in tropical and sub-tropical regions. Supplementary Report (Woolard F.) p. 70-88 - Constructional requirements to resist cyclones, based on experience from cyclone 'Althea' (Townsville, Dec. 1971), a tornado at Brisbane (Nov. 1973) and cyclone 'Tracy' (Dec. 1974); comments on existing standards and codes; accepts some, rejects others. Stresses need for 'engineering' design and proper inspection of works. Includes annotated photographs of failed structures and explanatory diagrams and detail drawings.

*(B.17) Sherman, Z. "Residential buildings engineered to resist tornadoes." American Society of Civil Engineers, Journal of the Structural Division, J99, n.St. 4 April 1973. Paper No. 9668, p. 701-714.

Testing design of a ranch-style wood-frame house for resistance to tornadoes. Used a system of X-cables in roof, walls and ceilings with bolted connections to carry forces many times greater than building codes require.

(B.18) Trollope, D.H. Cyclone "Althea" - Part I: Buildings. Townsville, Queensland, James Cook University of North Queensland, 1972. 240 p.

Reports on effects of cyclone 'Althea' in North Queensland on 24 Dec. 1971 (max. measured wind speed 122 m.p.h.). Concentrates on building behaviour in 6,000 houses and details damage to 34 modern houses: a subsequent report was devoted to storm surge and coastal effects.

Principal mode of failure was loss of roof sheeting and/or structure; often supplemented by failure of large windows and glass doors; flying debris was a significant factor in general damage. Photographs and diagrams illustrate. Recommends design practices for cyclone bolting, windows design and large roof overhangs, free standing masonry walls and masonry construction generally. Suggests special design practice for essential community services etc., as bunker type units to withstand maximum possible wind (180 m.p.h.). Recommends in some detail testing of roof structures and materials including timber structures on long-term basis, and revision of building codes, improved communication systems, and facilitation of emergency role for armed forces. Failure of steel pipe supports of street sign and hoarding enabled wind loads and speeds to be calculated retrospectively in various areas.

Includes bibliography (26 items) from 1948-1971.

(B.19) Unesco. Regional Office for Education in Asia, Bangkok. The Development of prototype schools for the cyclone-affected areas of Bangladesh. Unesco gift scheme; a proposal for submission to the donors. Bangkok, 1974. 14 p.

Recommends further development of plastic elements developed by CARE project, for cyclone-resistant school buildings. Illustrated with drawings and photographs of CARE system and proposed extension into related constructions.

(B.20) Walker, George R. Report on cyclone 'Tracy' and effect on building, December 1974. (Canberra), Department of Housing and Construction, March 1975, 3 vols. illus.

Reports on study set up after destruction of Darwin, Australia, on Christmas Day 1974. Destruction of buildings was described as almost total from very high winds.

Volume I (100 p.) includes chapters on Characteristics of Cyclone 'Tracy', General Pattern of Damage, Structural Behaviour, Implications of Disaster. Vol. II includes appendices I-V, Vol. III includes appendices VI-X. The following studies of cyclone effects on buildings are covered in the appendices:

I) Indication of Wind Velocities.
II) Investigation of Performance of Larger Buildings.
III) Investigation of Performance of Industrialized Residential Buildings.
IV) Appraisal of Roof Cladding.
V) Preliminary Report on Structural Damage.
VI) Interim Report on Storm Surge.
IX) Draft Building Code for Darwin Following Cyclone 'Tracy'.

Regional breakdown of above items

International	B.5, B.7, B.9, B.10, B.15
Asia (see also under countries)	B.1, B.2, B.8, B.14
Australia and South Pacific	B.3, B.4, B.5, B.12, B.16, B.18, B.20
Bangladesh	B.6, B.9, B.11, B.14, B.19
Central America	B.9, B.14
Philippines	B.7, B.9, B.13, B.14
U.S.A.	B.9, B.10, B.17

Floods

(C. 1) Cossins, G. and G. Heatherwick. January 1974 floods, Moreton region: proceeding of symposium held at Q. I. T., Brisbane, 3 & 10 April 1974. Institute of Engineers, Queensland Division, 1974. 275 p.

*(C. 2) Flood damage prevention - An indexed bibliography, 7th ed. Knoxville, Tennessee, Tennessee Valley Authority Technical Library, 1973.

*(C. 3) Flood control - economic aspects. Paris, Bureau Central d'Etudes pour les Equipements d'Outre-mer.

(C. 4) International Association of Scientific Hydrology/World Meteorological Organization/Unesco. Floods and their computation: proceedings of the Leningrad Symposium, August 1967 / Les crues et leur évaluation: Actes du Collogue de Leningrad, août 1967, Vol. 42, Louvain, Unesco/IASH, 1969.

(C. 5) Murison, H. S. and D. S. Woolard. Flood facts 1974: A report on the effects of the 1974 flood on house construction in Brisbane. Brisbane, University of Queensland, Department of Architecture, 1974. 42 p.

Reports on a survey of damage to about 500 houses undertaken hurriedly by architectural students following severe flooding of the Brisbane River caused by cyclone 'Wanda'. Damage to buildings and materials ranging from old vernacular timber construction to new masonry construction and composition sheet materials was recorded. Recommendations on building materials and methods for flood-prone areas (also issued separately) (see C. 8) are included as appendix. Statistical analysis is rudimentary, reports supplied are incomplete but consistent patterns of damage to various materials and design emerge.

(C. 6) Sewell, W. R. D. Flood damage prevention planning in developing countries. Ad hoc Group of Experts on Flood Damage Prevention, 3-6 December 1973. Victoria, British Columbia, University of Victoria, 1973. (ESA/RT/AC. 8/7)

*(C. 7) Snyder, F. ed. et al. Flood studies: an international guide for collection and processing of data. Paris, Unesco, 1971 (Technical Papers in Hydrology 8).

(C. 8) Woolard, F. W. Advice on repair and renovation of flood damaged houses. Brisbane, University of Queensland, Department of Architecture, 1974, 6 p.

Reports briefly on performance of building elements and materials of over 500 houses in January-February 1974 and makes recommendations on procedures for clean-up, repair and replacement.

Regional breakdown of above items

International	C. 2, C. 3, C. 4, C. 6, C. 7
Australia	C. 1, C. 5, C. 8
U. S. A.	C. 2

Earthquake, landslide and fire

(D. 1) Adams, R.D. "The San Fernando Earthquake", New Zealand Institute of Architects Journal, Vol. 38, No. 9, Sept. 1971. p. 283-289.

Reports on a California earthquake (magnitude 6½) in 1971. Briefly describes damage to a number of building types and structural materials; 10 descriptive photographs.

(D. 2) Ambraseys, N. W. "Earthquake Hazards and Emergency Planning", Build International, Vol. 5, No. 1, Jan./Feb. 1972. p. 38-42.

Text of a paper given at CENTO Conference at Ankara, Turkey, in July 1963; refers to planning before an earthquake and action to be taken afterwards. Proposes National Plan Organization to facilitate this; illustrated by chart, includes references.

*(D. 3) Ambraseys, N. W., A. A. Moinfar and J. S. Tchalenko. Gir Earthquake of 10 April 1972. Paris, Unesco, 1972.

(D. 4) Andrews, A. L. "Earthquake engineering and architectural design", New Zealand Institute of Architects Journal, Vol. 38, No. 9, Sept. 1971, p. 290.

Reprinted short editorial from Bulletin of New Zealand Society for Earthquake Engineering, demanding better integration of structural requirements with aesthetic ones. "There can be no compromise with earthquakes."

*(D. 5) Annual summary of information on natural disasters no. 7, 1972: earthquakes, tsunamis, volcanic eruptions, landslides, avalanches. Paris, Unesco, 1974.

(D. 6) Architectural Institution of Japan (Nihon Kenchiku Gakikai), Tokyo. Design essentials in earthquake resistant buildings. Amsterdam, Elsevier, 1970. 295 p. illus.

(D. 7) Benitez, Helena Z. 'Seismic engineers and building safety', Philippine Architecture Engineering and Construction Record, Vol. 18, No. 1, April 1971, p. 54-56.

Given to National Committee for Seismology and Earthquake Inquiry of the Philippines April 1971. Background to seismic provisions of recently introduced National Building code. Also mentions United Nations Regional Seismic Study Centre for South-East Asia.

*(D. 8) Boen, T. Basar Dasan Perent Janaan Bangunan Tahan Gemba (Basic principles for the design of earthquake resistant buildings), Bandung, Indonesia, 1969.

(D. 9) Caliwara, Cesar A. 'What happened to the case of the Ruby Tower and P. Guevarra School?' ASEP Journal, Philippines, Vol. 1, No. 1, p. 28-29.

Discusses Ruby Tower earthquake disaster in 1968 which killed 300 people, and 1970 destruction of P. Guevarra Elementary School in Philippines.

(D. 10) Caspe, M. S. "Technology: a new building technique damps earthquake forces at basement level", Architectural Forum, Vol. 132, No. 3, April 1970. p. 48-49.

Describes the 'Isolation Technique' developed in California by the author. This replaces the usually rigid connection between foundation and superstructure with movable, shock-absorbing devices that essentially divide the building into two distinct parts capable of independent lateral movement. Illustrated with detail drawings.

(D. 11) Daldy, A. F. Small building in earthquake areas. Garston, Eng., Building Research Establishment, Department of the Environment, 1972. 41 p.

Sets out in illustrated and tabulated form construction and design principles; aims at builders and on-site workers. Information is provided in simple and clear diagrams and notes. Basic recommendations for traditional and modern materials are given.

(D. 12) "A dialogue between Seismologists and Architects from three continents". Build International, Vol. 5, No. 1, Jan/Feb. 1972. Special Section, p. 7-53. (See also Nos. D. 2, 18, 20, 21, 24, 31, 40).

(D. 13) Duke, C. M. and M. Feigen. Proceedings of the symposium on earthquake and blast effects on structures. Los Angeles, California, 1952. 322 p.

Sponsored by Earthquake Engineering Research Institute and University of California. Attempts to consolidate technical knowledge on the subject and pass on in practical form to engineers and architects. Claims to be (in 1952) a fairly comprehensive reference book on earthquakes and blast forces on structures; analysis of structural response; properties of structures and materials; earthquake effects on structures; blast effects on structures; earthquake provisions of building codes. Includes 101-item bibliography of American earthquake studies up to 1952 (in R. W. Binder paper 'Engineering Aspects of the 1933 Long Beach Earthquakes') as well as shorter bibliographies, diagrams and illustrations to other papers.

(D. 14) Flores, Ambrosio R. 'The need for a Research Institute for Seismology and Earthquake Engineering', Philippine Architecture Engineering and Construction Record, Vol. 18, No. 1, April 1971, p. 72-74.

Briefly reviews the history of earthquake disasters in the Pacific region and elsewhere, the existence of research centres in Japan and the U.S. and twenty other countries; and advocates establishment of Philippine National Committee for Seismology and Earthquake Engineering. Includes in Appendix, Statutes of the International Association for Earthquake Engineering, approved 1965.

(D.15) Flores, Ambrosio R. The Luzon Earthquakes of 2 August 1968 and 7 April 1970. Paper delivered to Fifth World Conference on Earthquake Engineering, Rome, 1973. 12 p. Published Edigraf, Rome.

Examines examples of damage resulting from the earthquakes and makes recommendations for a Building Research Institute and other measures.

(D.16) Great Britain. Building Research Station, Overseas Division, Garston, Watford. Overseas Building Notes:

No. 63 Building in earthquake areas, 1959
No. 71 Earthquake-proof construction in low-cost housing, 1960
No. 118 Building regulations for seismic areas
No. 148 Building in earthquake areas.

(D.17) Hauf, H.D. 'Minimizing earthquake hazards; II: Architectural factors', American Institute of Architects' Journal, July 1968. p. 69-72.

Refers to characteristics of plan; preventing torsional movement caused by eccentricity between centre of mass and centre of rigidity, choice of materials, stairs as structural elements. (See also D. 37).

(D.18) Izumi, M. "Principles of earthquake resistant construction", Build International, Vol. 5, No.1, Jan/Feb. 1972. p.11-24.

Draws from Japanese experience and elsewhere. Proposes design principles and 'levelling' in structural design; also need for city-wide planning against destruction owing to impossibility of prevention of disaster to individual buildings. Sets out construction principles for various types of building—wood, masonry, steel, concrete; numerous detailed diagrams illustrating recommendations.

*(D.19) Koyna Earthquake, 11 Dec. 1967. Report of Unesco Committee of Experts, Vols.I and II. New Delhi, Government of India Press, 1968.

(D.20) Krishna, J. and B. Chandra. "Earthquake engineering in Asia", Build International, Vol.5, No.1, Jan./Feb. 1972. p. 35-37.

Discusses generally low-cost measures for strengthening various structures to decrease damage and danger to life. Illustrated with photographs and diagrams; draws generally on Japanese and Indian experience.

(D.21) Negoita, A. "Bearing walls in earthquake areas", Build International, Vol. 5, No. 1, Jan./Feb. 1972. p. 43-53. Based on a working paper submitted at Jasi in 1970 to a meeting organized by International Council for Building Research Studies and Documentation - CIB.

Looks closely at seismic behaviour of buildings with load-bearing masonry walls with and without openings, reinforced lintels and beams. Extensively illustrated and explained. Includes 56 references.

(D.22) New Zealand Institute of Architects Journal, Vol. 38, No. 9, September 1971. p. 283-293.

Reports on state of earthquake engineering in New Zealand. (See also D.1, D.4).

*(D.23) Okamoto, Shunzo. Introduction to Earthquake Engineering, Tokyo, University of Tokyo Press, 1973. 571 p., illus.

(D.24) Polyakov, S. V. "Seismic resistant structures in the USSR", Build International, Vol. 5, No. 1, Jan./Feb. 1972. p. 35-37.

Design of buildings is based on a code which gives a seismic design rating for a structure in terms of the use and local seismic history. Stresses need for solution of problems of earthquake design in traditional materials, particularly brick and masonry. Illustrated with photographs and diagrams; lists 17 references to work in USSR.

(D.25) Porphyrios, D. T. G. "Traditional earthquake-resistant construction on a Greek Island", Journal of Society of Architectural Historians, Vol. XXX, No. 1, March 1971. p. 31-39.

Describes anti-seismic practices and techniques traditionally adopted on Adriatic island of Lefkas, subject to a long succession of tremors, most recently in 1914, 1938 and 1948. Analysis in 4 categories - 1-storey buildings (living units); 1-storey buildings (churches), 1-storey buildings (storage rooms); 2-storey buildings - ground floor shops, second-floor living accommodation. Gives structural details and photographs of masonry and timber construction. Based on on-site observation, measurement, and information supplied by local craftsmen.

*(D.26) Proceedings of the International Seminar on Earthquake Engineering/ Acte du Colloque International sur le Génie Paraséismique. Held under the auspices of the Federal Government of Yugoslavia and of Unesco, Skopje, 29 Sept. - 2 Oct. 1964. Paris, Unesco, 1968.

(D.27) Reps, W.F. and E. Simiu, eds. Design siting and construction of low-cost housing and community buildings to better withstand earthquakes and windstorms. Report prepared for U.S. Agency for International Development. Washington, D.C., U.S. Department of Commerce/National Bureau of Standards, 1974. 152 p. illus. (Building Science Series no. 48)

Reports on a study on the potentials of applying housing standards to mitigate earthquake and windstorm disasters in developing countries and on relevant socio-economic and cultural constraints. Contributions included experience from Peru, Turkey, the Philippines, England, India, Iran, the Federal Republic of Germany and the U.S. The study extended from 1971-73. Attempts to provide background for assessing structural systems and materials used for earthquake and windstorm resistant construction. Discusses structural characteristics of buildings and building materials, structural performance of buildings under earthquake and windstorm conditions and factors responsible for damage or collapse; particularly in structures typical of developing countries. Examines failure due to structural configuration or aerodynamic features of building, foundation, walls, frames, roofs and floors. Shows examples where relatively simple measures can considerably improve resistance; e.g., horizontal roof bracing over adobe construction, design of openings in shear walls, reinforcement of critical areas and joints; includes traditional and industrialized construction methods. Reviews siting influences on effects of storm and earthquake and proposes policy steps in community planning and building codes. Assesses social and economic factors affecting construction in developing countries, including status grading of some materials and systems and possible modifications. Makes some suggestion on diffusion of knowledge of methods and systems.

*(D.28) Skinner, I. and M. Watable. Philippines: Eastern Luzon earthquake of 7 April 1970. Paris, Unesco, 1970.

*(D.29) The Skopje earthquake of 26 July 1963 / le tremblement de terre de Skopje du 26 juillet 1963. Report of the Unesco Technical Assistance Mission. Paris, Unesco, 1968.

(D.30) Tabujara, E.G. Structural considerations in earthquake-resistant design. Quezon City, College of Engineering, University of Philippines. 15 p. /n.d./

A qualitative approach to the philosophy of earthquake-resistant design by a civil engineer, applies mainly to buildings of some size. Comments on education, training and research. Appendix looks at aspects of national building codes for purposes of comparison (U.S.A., New Zealand, USSR, Japan, Yugoslavia).

(D. 31) Trajtenberg, M. "Peru, a year after disaster", Build International, Vol. 5, No. 1, January/February 1972. p. 25-26

Describes international reconstruction programme following 1970 Peru landslide; instructing local specialists and owner builders in construction techniques.

(D. 32) Unesco Regional Office for Education in Asia, Bangkok. Small buildings in earthquake areas. Bangkok, 1973. 10 p. (Educational Building Digest 2)

Recommendation for buildings up to 120 square metres in area and 2 storeys high.

(D. 32A) Unesco Regional Office for Education in Asia, Bangkok. Design against fire in schools. Bangkok, n.d., 12 p. (Educational Building Digest 7)

Introduces and explains in tabular form and with illustrations, nature of fire in buildings and principles of precautionary design.

(D. 33) United Kingdom. Department of Scientific and Industrial Research. Building Research Station. Earthquake-proof construction in low-cost housing. Garston, Watford, 1960. (Overseas Building Notes no. 71)

Briefly reviews CINVA publication by that name (Asismicidad en viviendas economicas; CINVA, Bogota 1959. Serie Tecnica No. 8 (in Spanish) from Centro Inter Americano de Vivienda y Planamiento, Bogota, Columbia). Covers similar ground to D.11, includes common constructional materials, adobe, reinforced concrete and wood. Useful for compiling low-cost building standards.

(D. 34) United Nations. Skopje resurgent, the story of a United Nations Special Fund town planning project. New York, 1970, 384 p.

The 1963 Skopje earthquake killed 1,000 and destroyed or severely damaged three-quarters of the city's buildings. The UN role was to co-ordinate international assistance with Yugoslav participation. A parallel Special Fund project was the Training Centre for Building Construction Personnel. Repairing methods derived in the field are recorded (p. 88). Many photographs, illustrations, maps and diagrams.

*(D. 35) India. University of Roorkee, School of Research and Training in Earthquake Engineering. Annual Report 1969-70, 1970-71, 1971-72. Roorkee, U.P.

(D. 36) U.S. Department of Commerce, National Oceanic and Atmospheric Administration Environmental Research Laboratories. A study of earthquake losses in the Los Angeles, California, Area. Washington, D.C., 1973. 331 p.

Report prepared for the Federal Disaster Assistance Administration Department of Housing and Urban Development. Divided into Part A (Isoseismal Studies) and Part B (Casualties and Damage) each with ample bibliographies. Part B includes demands on health and medical manpower and resources, and effects on vital public needs - public structures, communications, utilities, and schools. Includes (p. 287) references to studies of California schools.

(D. 37) Wallace, R. E. "Minimizing earthquake hazards; I: Geologic factors" American Institute of Architects Journal, July 1968. p. 65-72. (See D. 16)

(D. 38) Watabe, Makoto. 'Aseismic structural systems for buildings', Technocrat, Vol. 7, No. 1, 1974, p. 99-107, and Vol. 7, No. 2, p. 86-98.

Gives technical basis for aseismic design for modern framed and masonry structures. Examples and references from various international sources. This is No. 2 of a series of nine articles 'Recent Progress of Earthquake Engineering in Japan' giving comprehensive coverage to recent Japanese discoveries in earthquake engineering. General supervisor of the series: Keizaburo Kubo. (Series continues to Vol. 7, No. 8). The other articles in the series are:

1) Omote, S. 'Earthquake disasters and earthquake engineering'
3) Shibata, H. 'Aseismic systems for production facilities'
4) Okubo, T. 'Aseismic considerations of transportation systems'
5) Sato, S. 'Aseismic systems reconsidered from the viewpoint of urban engineering - with emphasis on urban redevelopment'
6) Usami, T. 'Studies and systems for predicting earthquakes in Japan'
7) Kobayashi, H. 'Estimation of earthquake damage in urban areas in the light of surface layer dynamics'
8) Ishihara, K. 'Soil dynamics'
9) Iwasaki, T. 'Response analyses of civil engineering structures subjected to earthquake motions'.

*(D. 39) Weigel, R. L. ed. Earthquake engineering. Englewood Cliffs, N. J., Prentice Hall, 1970.

(D. 40) Working Group. "International collaboration in earthquake engineering", Build International, Vol. 5, No. 1, January/February 1972. p. 7-10.

Outlines research and education in earthquake engineering, schools promoting earthquake engineering and international and regional conferences, notes desirability of better dissemination of existing knowledge.

Regional breakdown of above items

International	D. 2, D. 5, D. 6, D. 11, D. 12, D. 13, D. 14, D. 18, D. 21, D. 23, D. 26, D. 27, D. 32, D. 32A, D. 38, D. 39, D. 40.
Asia (see also under countries)	D. 19, D. 20, D. 27, D. 35
Australia and South Pacific	D. 4, D. 22, D. 30
Europe	D. 27, D. 29, D. 30, D. 34
Greece	D. 25
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Japan	D. 6, D. 18, D. 23, D. 30, D. 38
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South America	D. 31, D. 33
U. S. A.	D. 1, D. 10, D. 13, D. 17, D. 36, D. 37
U. S. S. R.	D. 24

Codes and standards

(U.S.A.) (Disasters) — Office of Emergency Preparedness, Disaster preparedness, Vols. 1-3, Washington, D.C. Official Emergency Preparedness, January 1972.

Gives a summary of U.S. Federal disaster legislation.

(Australia) (Wind) — Draft building code for Darwin following cyclone 'Tracy' from Darwin Reconstruction Study 1975, Department of Housing and Construction (Vol. 3, Appendix 9) (See B. 20).

Proposes adoption of new cyclone provisions, combined with new Australian Model Uniform Building Code. Considers some existing Australian building codes inadequate, notably:

Aust. Standard 1170	- Minimum design loads on structures
Aust. Standard CA. 38 - 1971	- Light timber framing code
Aust. Standard 1562	- Designed installation of self-supporting metal roofs
Aust. Standard CA. 32 - 1967	- Code for concrete masonry.

Stresses importance of inspection of works.

(Australia) (Wind) — Loading Code - Wind Forces
S.A.A. Code CA. 34 Part II Standards Association of Australia, North Sydney, N.S.W. Australia.

Prescribes design wind velocities according to terrain and geographic location. Includes recommendation for assessment of special site conditions which may cause winds greater than normal maximums.

(Bangladesh) (Wind)
(U.K., U.S.) — British standards code of practice No. 3, Chapter V, 1952. (See B. 14)

American Society of Civil Engineers report on wind loading (1936)
Standards recommended for wind load standards for Bangladesh. (See B. 14)

(New Zealand) (Wind) — Model Building By-law, N.Z., S.S. 95, Part IV (See No. B. 12)

(International) (Earthquake) Model legislation and regulations for earthquake resistant building produced by Tropical Division, United Kingdom, Building Research Station. (See A.2)

(Earthquake) Earthquake resistant regulations - a world list, International Association for Earthquake Engineering, Tokyo, 1966. (See D. 12, p. 10)

(International) (Earthquake) Statutes of International Association for Earthquake Engineering, approved 1965. (Appendix in Flores, No. D.14)

(India) (Earthquake) Indian Standards Institution
IS. 4326 - 1967
IS. 1893 - 1966
IS. 4967 - 1968

(Japan) (Earthquake) Japanese earthquake code mentioned in Build International, January, February 1972, p. 21, G. Izumi paper. (See No. D.18)

(New Zealand) (Earthquake) National Building Codes compared in Tabujara
(U.S.A.) paper. (See No. D. 30)
(U.S.S.R.)
(Japan)
(Yugoslavia)

(Philippines) (Wind and Earthquake) National Structural Code for Buildings, Association of Structural Engineers of the Philippines. (See also U.S. National Bureau of Standards Series No. 56: B.9 . See also D. 7)

(Earthquake) Building codes for earthquakes chapter in D. 13.

(U.S.) (Earthquake) American Institute of Architects Journal July 1968.

Discusses codes and ordinances and refers particularly to schools in earthquake proof design. (See D. 37)

(U.S.S.R.) (Earthquake) USSR Codes referred-to in Polyakov. (See No. D. 24)